Research Proposal: Effects of WWTP mixing zone on salmon fry

Background and Need

The City of Palmer (CoP) has discharged effluent from the wastewater treatment plant (WWTP) to a tiny clear water side channel of the Matanuska since 1946. The channel has been stable since 1988 without major flooding. EPA observed salmon spawning at the outfall and imposed stringent ammonia limits to protect the salmon, requiring compliance by 2011.

There has been little field investigation of impacts of WWTP discharges on salmon (here or anywhere). The EPA regulations simply presume that the discharge has deleterious effect on salmon due to ammonia; limits are derived from a single 1979 study on egg mortality. This presumption is starkly contradicted by observations of the discharge stream which indicate high salmon fecundity relative to other similar and adjacent streams bordering the Matanuska.

The CoP asked me to help them with WWTP compliance last spring. Previous engineering estimates for NPDES compliance ranged from $25-50 million, far beyond the ratepayer base ability to fund or maintain. There was high probability none of the seven systems considered could even meet ammonia limits using EPA calculations.

My first recommendations included negotiating with EPA to allow ecological studies of salmon in the discharge stream as a partial basis for system design, such as constructed wetlands on the revegetating gravel bar. A request sent to habitat biologists for baseline salmon data proposals was included in the CoP's 5/8/08 letter to EPA (this and extensive additional backup can be provided upon request). ADEC was handed responsibility for this permit in late summer and NPDES authorization in November, with the general caveat of "no backsliding".

Without some concurrence and direction from regulators on use of stream salmon studies for permitting or system design, the CoP could not fund the research proposals received. I then provided preliminary concept and design on an upland soil absorption system, which would avoid an NPDES (APDES) permit for surface discharge and short term costs are less than other alternatives. Nutrients and their effects on salmon will be removed from the stream, and only limited expansion is feasible. An alternative absorption system on the gravel bar could retain nutrients for ecological enhancement of wetlands, accommodate expansion to regional size, be potentially cheaper, but would require salmon habitat studies and multi-agency negotiations.

The only quantitative salmon data to date is a spawning survey from last fall; the discharge stream had ~6500 escapement compared to ~4100 combined total for four similar streams in the delta. The discharge stream had neither the largest flow, greatest surface area, nor length. Additional observations include fry densities April through July of 2008 and the past couple weeks; fry densities within the mixing zone appeared to be 10-100 times the densities across the stream or above the WWTP outfall, and fry remained longer in the summer.

Thus, drastic very expensive changes to a long established balance are required by EPA generic criteria to mitigate presumed deleterious effects on salmon, despite empirical evidence indicating the WWTP discharge enhances salmon. There was no provision in EPA's NPDES regulatory process for examining actual effects of the discharge on salmon productivity or using those results

to direct a site specific permit and the associated WWTP system to try to improve salmon habitat. Alaskan fisheries experts are shut out of this permit process, and regulators are denied their considerable expertise when it matters most.

If the applied regulations could reasonably be expected to improve salmon habitat, no research at this site would be needed. Since the opposite applies, research is needed to identify WWTP upgrades and permit criteria most likely to result in habitat improvement. This implies cooperation between regulators and biologists; given recent state primacy-in-training for CWA, I believe the time is right.

But, somebody has to start. Since agencies apparently do not have the time, authority, and resources combination to do any research for this fry out-migration, I will volunteer. I am not currently working for the city or regulatory agency and will fund this myself. I hope to borrow CoP field test equipment including flow gage, digital balance, and NH_3 and DO meters.

Objectives

The effects of the mixing zone on salmon fry growth and survival for a period of six weeks will be examined. The primary objective is quantitative comparisons of ammonia concentrations versus growth and survival of the fry. Secondary objectives include dynamic mapping of the mixing zone for additional water physical/chemistry parameters including flow rate, ammonia/nitrite/nitrates, phosphorous, pH, temperature, turbidity and dissolved oxygen using quantitative field tests with spot correlation to contract labs. Additional semiquantitative information will be gathered, including photos and videos of fry densities.

Procedures

Sockeye and chum fry will be placed in six mesh cages located in similar spots inside and outside of the mixing zone; see Figure 1 and photo for locations. There will be three "pairs" of cages, in and out of the mixing zone. Each pair will have similar flow, depth, velocity, and substrate. Setup will include initial physical and chemical stream measurements.

Cages will be approximately 2x2x1 ft with ½ inch galvanized steel frame enclosed on all sides with "pet screen" plastic mesh (~2 mm openings) with removable lid. They will be placed near the bank in depths of 6-10 inches and secured with metal stakes with the bottom mesh in contact with the streambed. Cages will include tags indicating purpose and contact information.

Fry will be captured from the stream with a dipnet and sorted by species. In late April, the distribution appeared to be a relatively equal mixture of sockeye and reds; coho appeared late in the fall in smaller numbers and were not yet observed as fry. Identification was difficult for many fry, which were recently past alevin stage, most <3-4 cm fork length. To minimize stress, captured fry will be immediately placed in a bucket of stream water from capture zone. Sorting by species will entail scooping into a glass of water and observing parr marks. Ten fry of each species will be weighed en mass, transferred into separate containers, then gradually introduced into each of the six cages.

Once per week the fry will be observed for mortality/species and survivors weighed en mass. Dead fry will be individually weighed and species noted. Water physical/chemical parameters will be measured. After six weeks, individual fry will be weighed and released.

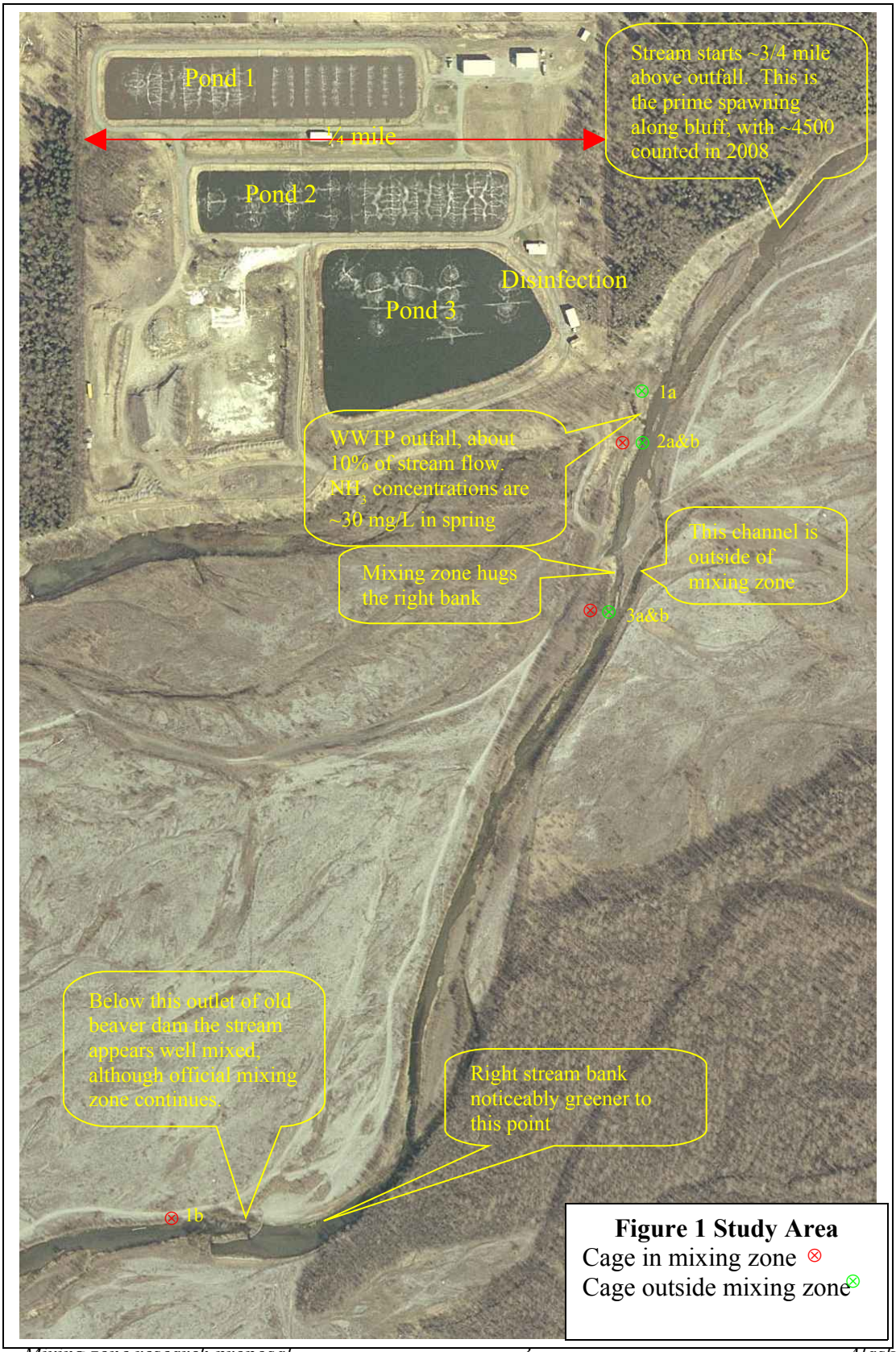

Figure 1 Study Area
Cage in mixing zone ⊗
Cage outside mixing zone ⊗

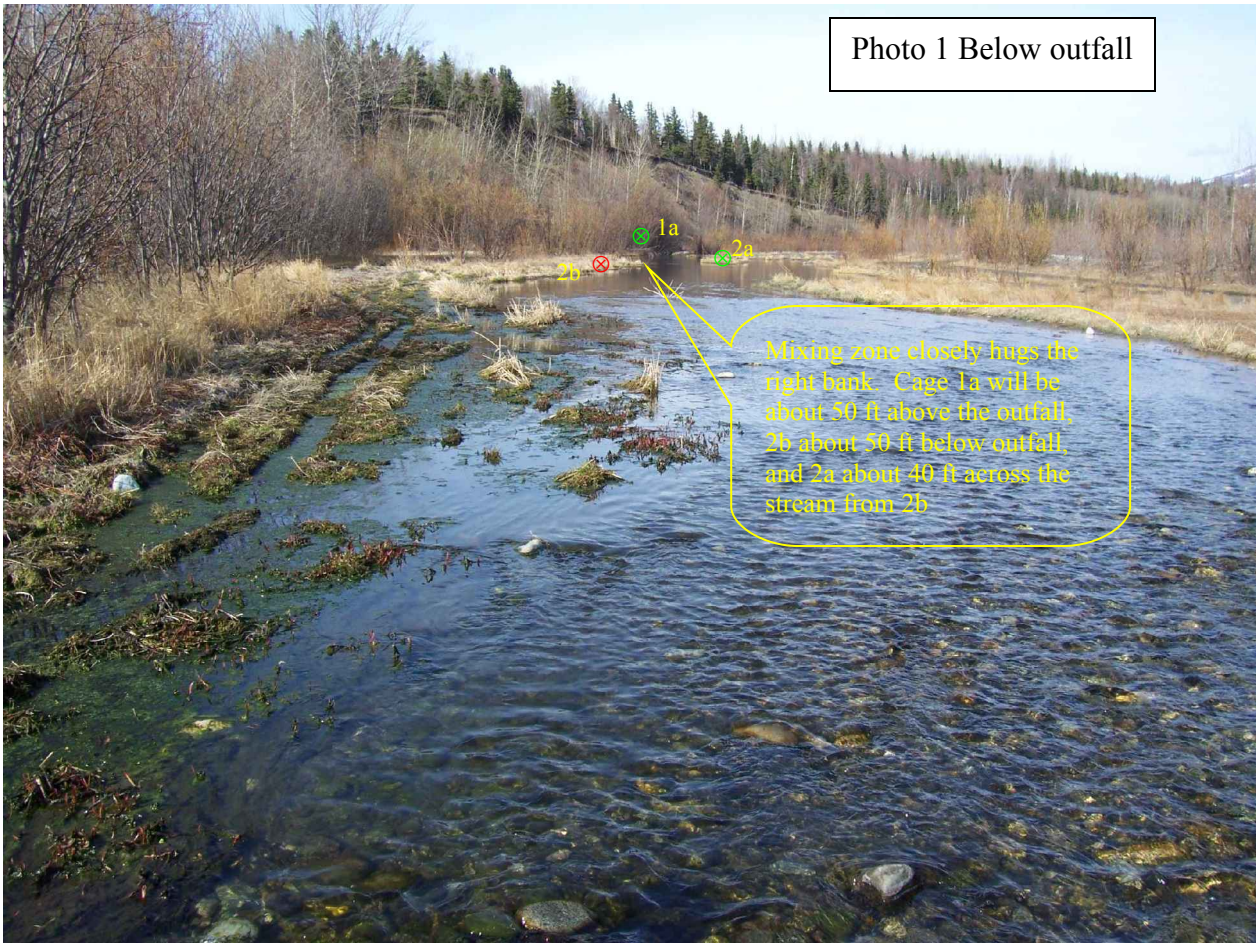
Photo 1 Below outfall
1a
2a
2b
Mixing zone closely hugs the right bank. Cage 1a will be about 50 ft above the outfall, 2b about 50 ft below outfall, and 2a about 40 ft across the stream from 2b